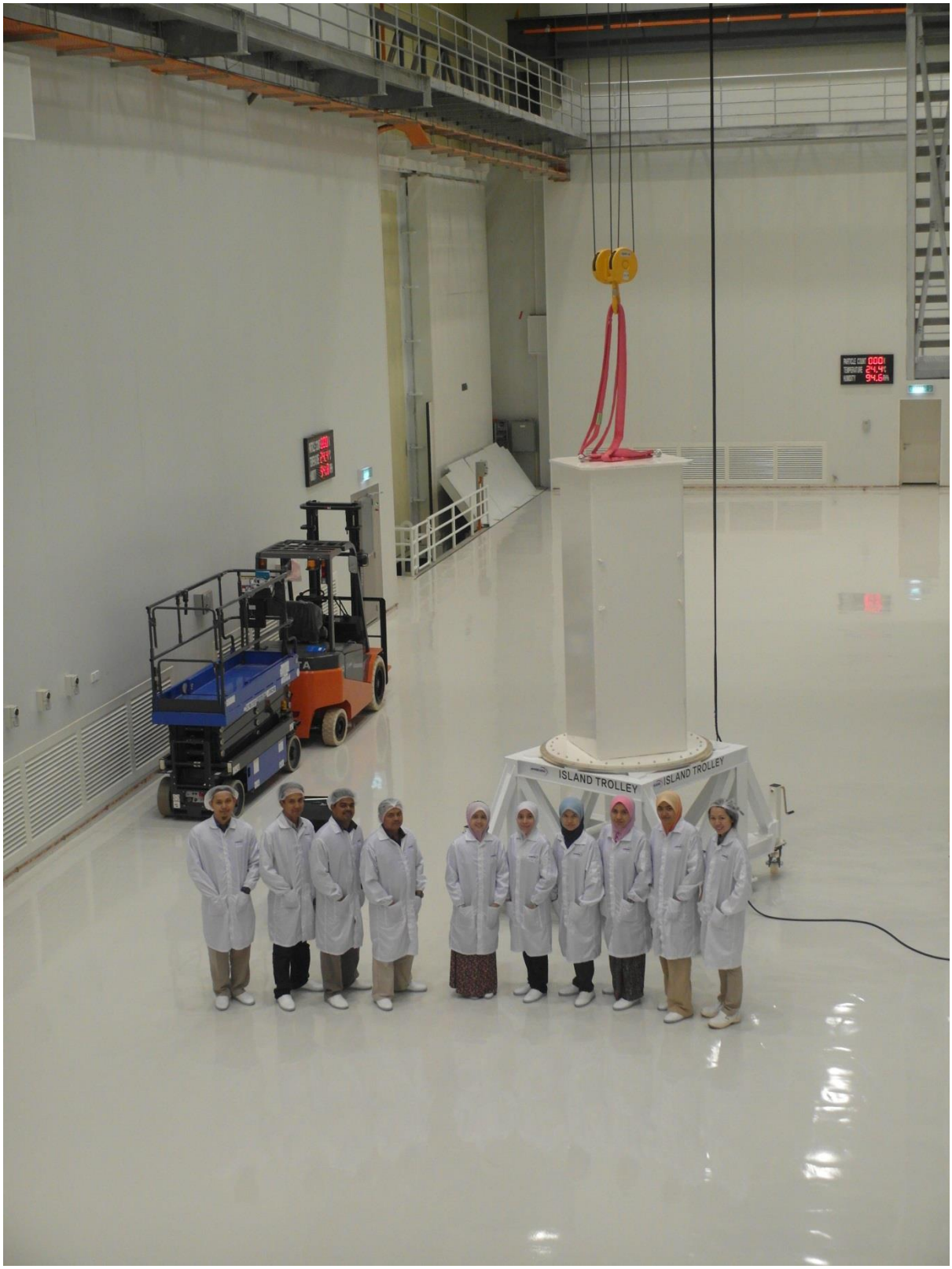
Satellite Assembly, Integration and Test Centre (AITC)

Introduction:

In any spacecraft development, be it a manned or unmanned mission, for scientific research or as a space transportation, a spacecraft with its payload must be able to withstand the rigors of the lift-off and ascent environment occur during the launch phase, and, the extreme thermal conditions and operational environment experienced by the spacecraft and its payload once it is in orbit. This include the effects of intense acoustic and vibration generated by engine ignitions during lift-off, shocks generated during separation of stages and fairing, shocks during deployment of solar panels, temperature variation between extreme hot temperature to extreme cold temperature, vacuum condition, solar radiation and many other effects experienced by the spacecraft. Both mechanical and thermal effects introduced a lot of constraints on the structure design of a spacecraft and therefore, it must be thoroughly tested up to the system components to ensure the survivability of the spacecraft and its payload in space. And the testing conditions on Earth should simulate as close to as what will be experience by the spacecraft and its payload upon lift-off and while in space.

The Satellite Assembly, Integration and Test Centre (AITC) completed in 2011, is a facility that will provide those testing conditions as what will be experience by the spacecraft and its payload. The cost of a building a spacecraft is never cheap, thus, making it even more important to have it thoroughly tested on ground to ensure survivability of the spacecraft exceeds what it has been design for. Therefore, the AITC facility is constructed to accommodate the testing requirements of both ground-based instruments and fully qualified space-flight hardware.

It is able to offer a wide spectrum of test services, such as the vibration and acoustic test, thermal and vacuum test, electromagnetic compatibility test, as well as mass properties and alignment measurement, all under one roof.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Environmental Conditions of the Facility:

Temperature:	22 ± 2°C
Humidity:	50 ± 5% RH
Particle (<0.5μm):	100,000 unit / ft^3
Ground Connection:	< 1.0 Ω

- ✓ DUT Receiving Airlock
- ✓ Spacious high bay for integration works
- ✓ Mechanical ground support equipment such crane, forklift, etc., are available

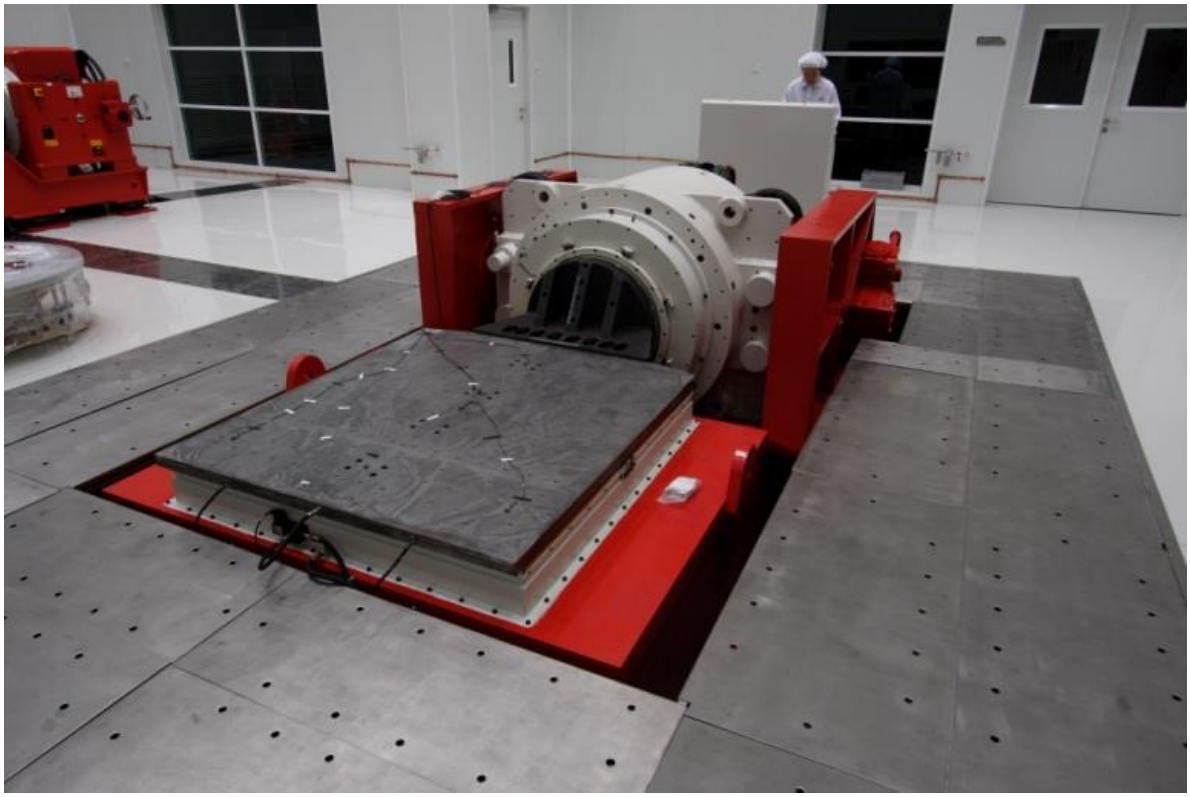
Services offered at this facility:

- Sine and/or Random Vibration Test
- High Intensity Acoustic Test
- Thermal and Vacuum Test
- EMI/EMC Test
- Mass Properties Measurement
- Alignment Measurement

VIBRATION TEST

The vibration test is used to simulate the low frequency caused by the launch vehicle during launch process, to ensure that the satellite can withstand the maximum expected flight environment. Vibration tests are conducted to verify the strength and stiffness of the satellite and whether the satellite can function normally after being exposed to such vibrations. This test is critical to ensure that the design and analysis of the satellite's structure meets the requirements of the launcher.

It can also be used to conduct vibration tests for other non-space indusdries.



Main Specification	Model V994	Model V9
Max Sine Thrust	289 kN	105 kN
Max Random Thrust	267 kN	105 kN
Max Velocity	2.0 m/s	3.0 m/s
Useful Frequency	5 – 1700 Hz	5 – 2700 Hz
Max Load (10g Vector)	2693 kg	1070 kg

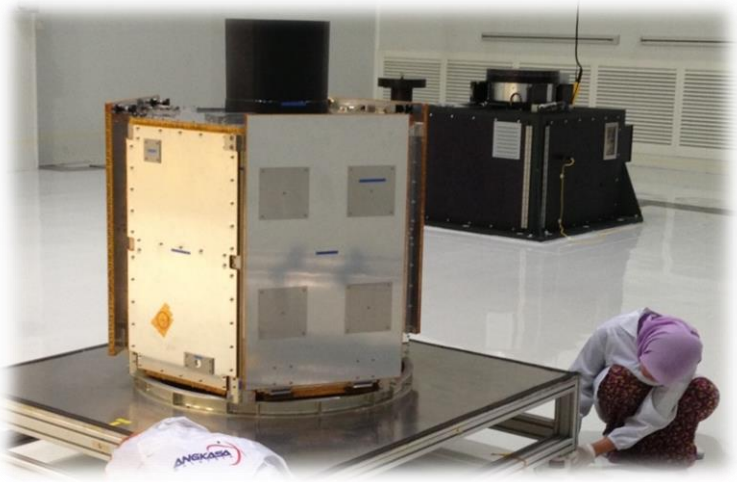
ACOUSTIC TEST

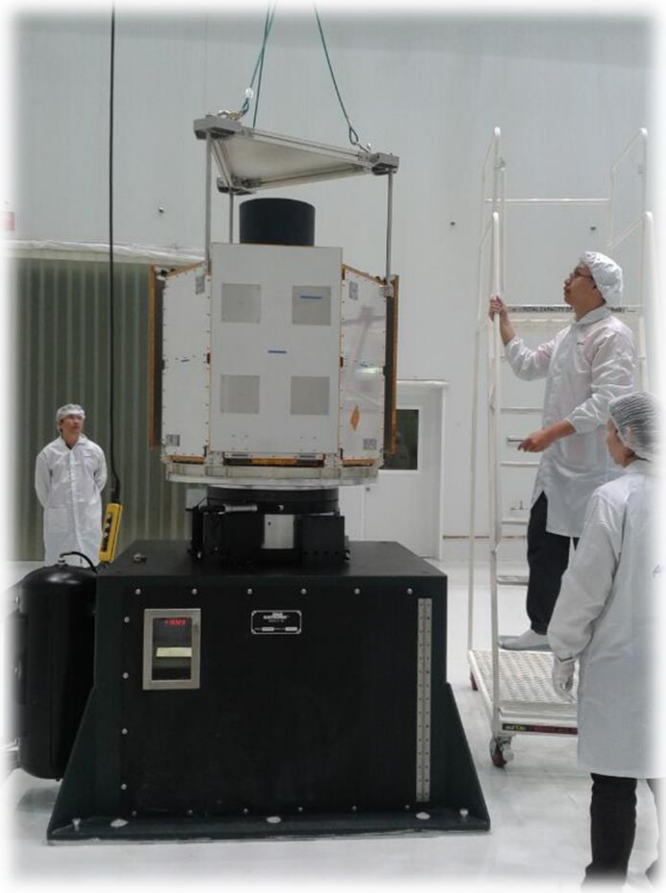
The acoustic chamber is used to simulate the launch process, where tremendous amount of noise generated in the exhaust plume flowing from the nozzle as the launch vehicle lifts off. The exhaust gas velocity maybe as high as 10,000 feet per second and some of the acoustic energy reflects off the ground and propagates into the vehicle's nosecone. This energy is radiated as sound pressure into the internal volume of the nosecone, where the spacecraft is located in the launch vehicle. In this facility, the noise is generated using gaseous nitrogen coupled with noise producer to transform the kinetic energy of the gas into an acoustic waveform which is then directed into the chamber through specific horns.

Main Specification	
Chamber Volume	$\cong 999.5\ m^3$
Overall Sound Pressure Level	155 dB
Frequency Range	20 – 10,000 Hz
Sound Generating System	Gaseous Nitrogen (GN2)

MASS PROPERTIES MEASUREMENT

The mass property measurement system will be used to determine and measure precisely and accurately the physical properties of the satellite, its subsystems and payloads, i.e. to determine the centre of gravity and moment of inertia of the satellite in order to provide for satellite positioning control during orbit insertion and attitude control.





Main Specification	
Max Test Weight • Static • Dynamic	1300 kg 1000 kg
Max Moment of Inertia	1463 kgm^2
Range of Spin Speed	30 – 300 rpm
Min Achievable Readout at 100 rpm	44 $kgmm^2$

THERMAL VACUUM TEST

Thermal vacuum chambers are used to simulate the environment in space where the satellite will be orbiting. At times when the satellite is facing sun, temperature can go up to 100°C and above, and at times when the satellite is in eclipse; the satellite can be exposed to a temperature of -100°C and below. Therefore, it is critical that the satellite is tested and verified that it will be able to operate under space's extreme hot and cold environment and near vacuum condition. The system will be able to support thermal vacuum and thermal balancing tests. The satellite will be placed securely in the chamber and air will be pumped out to reach a certain level of pressure. Liquid nitrogen, gaseous nitrogen and infrared lamps are used as temperature control.

Main Specification	
Operational Volume	3.7 m (ϕ)
Ultimate Pressure	10^{-7} mbar
Pumping Rate	10^{-6} within 5 hours
Temperature Range	-180°C – 150°C

EMI / EMC TEST

An EMC chamber is used to test and ensure that the electrical and electronic parts in a satellite will not generate electromagnetic disturbances, which may influence other parts of the satellite. In other words, it deals with problems of noise emission as well as noise immunity of the electrical and electronic components and system. It has the capability to conduct EMI/EMC testing in full accordance to MIL-STD-E.

Main Specification	
Operational Area	5m Compliance Full Anechoic Chamber
Frequency Range	20 Hz – 40 GHz

ALIGNMENT MEASUREMENT

The alignment measurement is used to undertake precision geometrical alignment measurement specifically for satellite component alignment. The system comprises of two units of theodolites complete with alignment optics, one unit of rotary table, one unit of flat table and two units of vertical tooling stand as well as data acquisition system.

Main Specification	
Theodolite System Accuracy	0.5 arcsecond
Rotary Table • Indexing Accuracy • Repeatability	± 5 arcsecond ± 1 arcsecond